

GIS plays a key role in Miami flood mitigation

CHAPTER: Making decisions under pressure

ORGANIZATION: Miami-Dade Office of Emergency Management

LOCATION: Miami, Florida

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PROJECT: Expediting a flood-control project

SOFTWARE: ArcInfo, ArcView

ROI: Cost and time savings; increased efficiency, accuracy, and productivity

By Soheila Ajabshir and Frank Reddish

South Florida flooding—it's a known hazard. Five or six inches of rain will cause a flood somewhere in Miami-Dade County. More than twelve inches of rain will cause a flood everywhere in Miami-Dade County. Because the topography of south Florida provides virtually no slope to the land and the water table is only a few feet down, heavy rainwater tends to stay put and not run off, even though there are canals everywhere.

Tropical Storms Gordon (1994) and Leslie (2000) along with Hurricane Irene (1999) each brought more than twelve inches of rain and massive flooding to the county. After Tropical Storm Leslie, Miami-Dade County's Office of Emergency Management (OEM) began the implementation of a flood-control program designed to end the flooding—a huge job that called for the cooperation and involvement of many federal, state, and local agencies.

Federal agencies included the Federal Emergency Management Agency (FEMA), the U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, National Park Service, U.S. Fish and Wildlife Service, Bureau of Indian Affairs, and National Marine Fisheries Service. At the state level, the South Florida Water Management District, Florida Department of Community Affairs, and Florida Department of Environmental Protection engaged in the effort.

On the county level, the Miami-Dade County Office of Emergency Management, Public Works, Department of Environmental Resources Management, and the Board of County Commissioners Flood Management Task Force participated. The cities of Miami, Sweetwater, and West Miami were also involved. Two large engineering companies from the private sector, URS Corporation and PBS&J, participated. And other organizations such as the Miccosukee Tribe of Indians, the Audubon Society, and the Sierra Club also contributed.

A flood committee made up of representatives of these agencies immediately went to work to define the problem and recommend a solution. The C-4 Basin Initiative, named for the Tamiami Canal Basin, or C-4 Basin, was the result and entailed a massive engineering undertaking involving hydrology, hydraulics, and civil engineering. With all the agencies working together, the project was completed in four years. In addition to interagency

cooperation, GIS played an integral role in the project's implementation and enabled the group to present the concept in a way that was easily visualized by the widely differing organizations.

ESRI's ArcInfo and ArcView GIS software played a crucial role in the research phase. There are approximately twenty hydrological basins or watersheds within Miami-Dade County. ArcInfo software and land-elevation data were used to create the Canal's Basin Area Polygon shapefile, applying the contours of the various hydrological basins that indicate which canal or waterway forms each basin.

After these basin or watershed contours were identified, ArcView was used to "intersect" the basin layer with the population layer to estimate each basin population. The same geoprocessing capability of ArcView helped to determine the total number of lane-miles of flood-damaged roads, the number of flood claims filed with the National Flood Insurance Program, the number of loans issued by the U.S. Small Business Administration, and the number of assistance grants issued through FEMA's Individuals and Households Program. An inventory of FEMA repetitive-loss properties (properties where a flood insurance claim has been paid on the same structure two or more times) within each basin was also included.

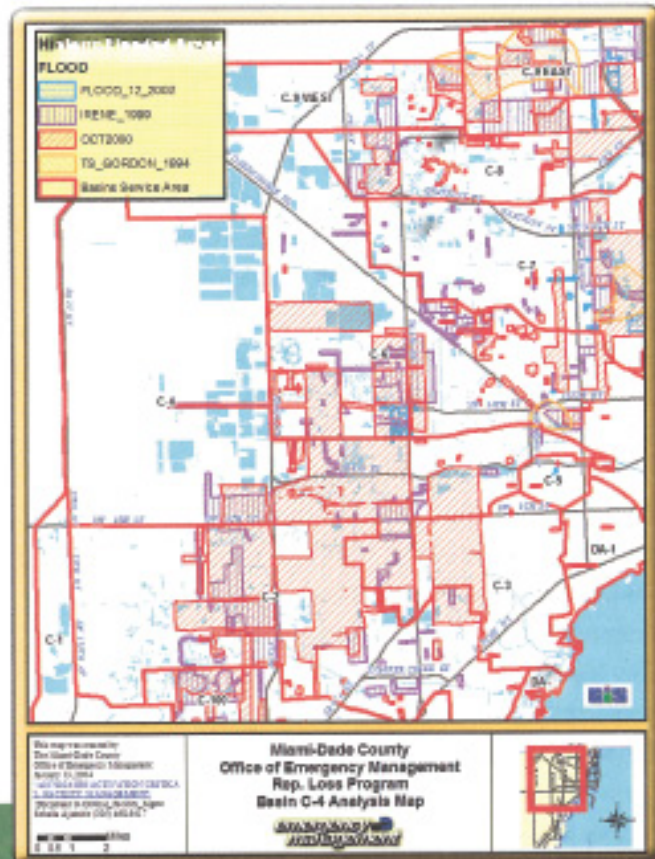


Figure 4.3 Map shows the areas in Miami-Dade County flooded in several severe tropical storms, including Irene and Gordon.

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Using a mutually agreed upon weighting scale, the committee started the project with the C-4 Basin, which moves water from the Everglades in the west and flows into the Miami River (C-6 Canal) east of Miami International Airport. The Tamiami Canal starts in one national park (Everglades) and ends in another (Biscayne) and traverses an Indian reservation, a critical wetland, and several municipalities.

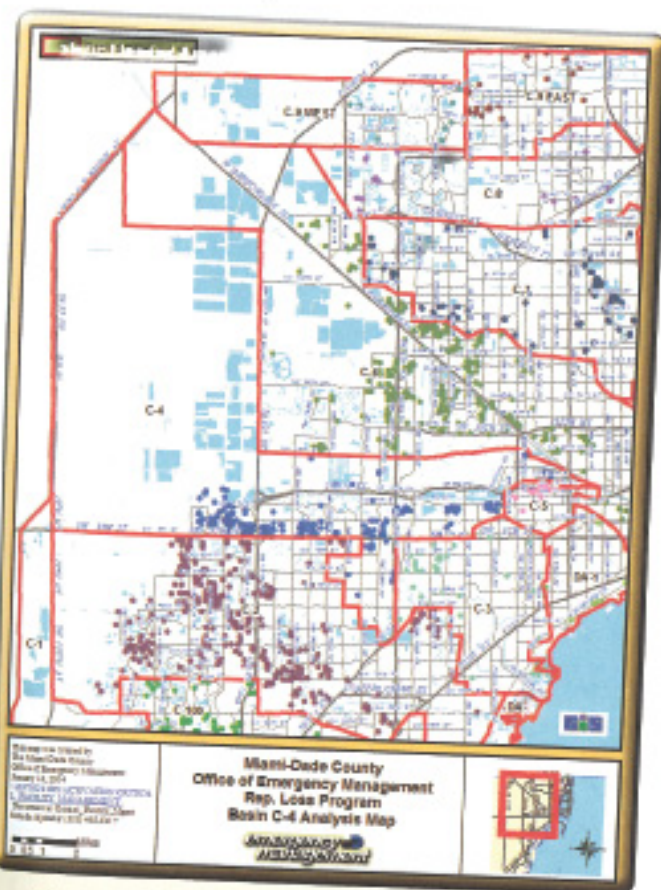


Figure 4.4 The Miami-Dade County flood-control program started with the C-4 Basin.

The timeline for the C-4 Basin Initiative was quite short compared with other public-works projects of this size. The flooding event happened in October 2000, with the concept for a solution formulated within two months. Engineering design and permitting began in January 2001, and by July 2001, the first-phase groundbreaking occurred for the installation of a massive pump to move water against the tide. The pump is large enough to fill a standard swimming pool in three seconds. The first phase of the project was completed in January 2002, less than eighteen months after the flooding occurred.

Another phase of the project was the installation of a similar pump in the adjacent Miami River to prevent the massive amount of water in the C-4 Canal from overwhelming the river's flow. The project also involved the construction of two 500-acre emergency detention reservoirs, including a supply canal and pumps to divert the water flow from the Everglades and create capacity in the C-4 Canal to handle the additional rainfall and runoff. Other phases included the installation of street drainage in the communities along the canal and the adding of a berm to raise the canal bank by several feet.

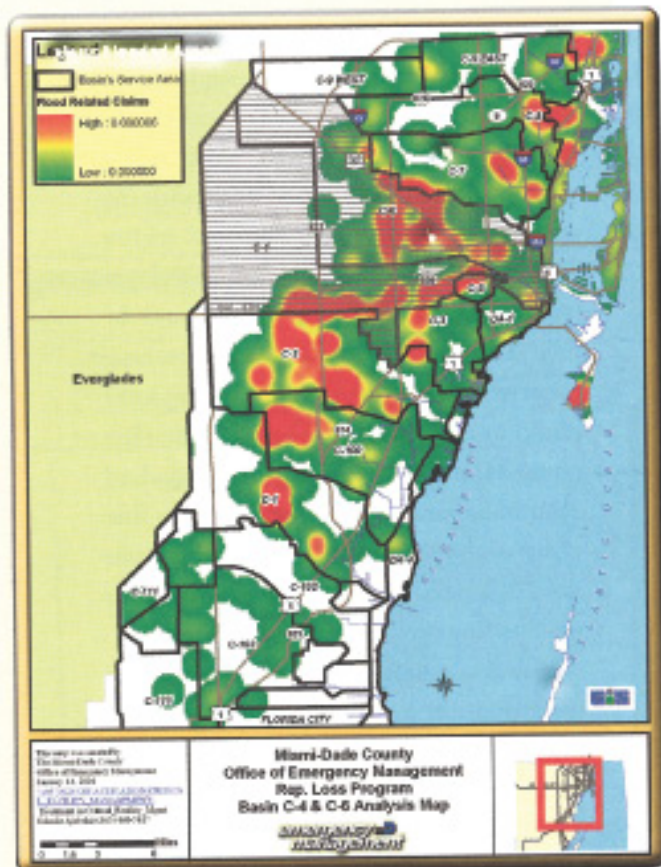


Figure 4.5 Map shows the historic flood concentration in the C-4 and C-6 basins based on repetitive-loss properties, with two or more claims.

All phases of the C-4 Basin Initiative were completed by early 2005. The first test of the project came in August 2005 when Hurricane Katrina passed through Miami-Dade County. To the relief of the flood committee and thousands of county residents, the C-4 Basin did not flood. Mitigation projects such as the C-4 Basin Initiative proved to be an effective method to better prepare communities for disasters. GIS proved it can be as valuable an asset in disaster mitigation as it is in disaster

response. Because of the C-4 Basin Initiative, local, state, and federal governments as well as the residents of the basin have saved millions of dollars, and they are savings that will continue.

ArcInfo was used to create a polygon layer called Basin including each canal's service area. The geo-processing capability of ArcView was used to intersect the Basin polygon layer with essential data such as population, number of flood claims, dollar values associated with the claims, and affected roads. Using ArcView Charts made it easy to visualize and compare the twenty basins and quickly prioritize the affected canals. The ArcView Spatial Analyst extension helped to show the density and concentration of the problem basins.

ArcInfo and ArcView software and extensions were used to create and then map a hydrological-basins table, which prioritizes the various basins and provides a starting point for the C-4 Basin Initiative.

Hydrological basins in order of priority

Rank	Basin	Population (30%)	Points	Flood claims (50%)	Claim points	Lane-miles damaged (20%)	Lane points	Total points
1	C-4	493,377	42	5,312	124	50.60	49	215
2	C-6	750,197	64	3,885	91	44.50	43	198
3	C-7	714,843	61	4,908	115	4.20	4	179
4	C-8	178,988	15	2,028	47	32.40	31	94
5	C-9-E	141,982	12	2,248	52	8.40	8	73
6	C-2	188,440	16	820	19	29.20	28	63
7	C-3	443,625	38	78	2	.70	1	40
8	C-100	179,894	15	710	17	.40	0	32
9	C-1	90,000	8	560	13	4.30	4	25
10	C-102	40,800	3	718	17	4.82	5	25
11	Coast	164,528	14	0	0	10.00	10	24
12	C-103	68,650	6	157	4	12.70	12	22
13	C-9-W	32,000	3	1	0	2.50	2	5
14	C-111	35,331	3	0	0	2.20	2	5

Table 4.1 Prioritization of flood risk for canal basins in Miami-Dade County.

GIS software helped staff members save tremendous amounts of time as it geospatially analyzed all critical data and recommended priorities within a short time frame. It also helped policy makers visualize the priorities.

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